

SPECIFICATION 654 – TRAFFIC SIGNAL SYSTEMS

654-1 DESCRIPTION

654-1.01 Scope

- a. This work shall consist of furnishing, installing, adjusting and fine tuning new traffic signal systems in accordance with these specifications and in conformity with the locations, dimensions and details shown on the plans or established by the Engineer.
- b. Each traffic signal system shall include the traffic and pedestrian signal heads, the signal support structures, the detector units, the local and master controllers, conduits, pull boxes, handholes, electrical conductors, telecommunications cables, and all hardware, fittings, appurtenances, materials and equipment required to provide a complete operational system as specified and as shown on the plans.
- c. When so indicated in the contract documents, this work shall also include the maintenance, modification, replacement or removal of existing traffic signal systems as shown on the plans and as directed by the Engineer.

654-1.02 Definitions - The following definitions pertain to work, equipment and materials used in traffic signal systems. Terms not included herein but pertaining to detectors, controllers, signals, signal supports and mounting hardware are as defined in NEMA Standards Publication TS-1 - Traffic Control Systems.

Actuation - The operation of any type of detector.

Controller Assembly - A complete assembly for controlling the operation of a traffic signal, consisting of a controller unit and all auxiliary equipment housed in a weatherproof cabinet or cabinets.

Controller Unit - That part of the controller assembly which performs the basic timing and logic functions.

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Cycle - A complete sequence of signal indications.

Cycle Length - The time in seconds required for one complete cycle.

Detector - A device for indicating the passage or presence of vehicles or pedestrians.

Flasher - A device used to open and close signal circuits at a repetitive rate.

Induction Loop Detector System - A detector consisting of a wire loop embedded in a precast concrete slab placed in the roadway surface, or embedded in the deck of a structure, and connected to an electronic device that is capable of sensing the passage or presence of either moving or stationary vehicles by the change in the electrical inductance characteristics of the wire loop.

Interval - The part or parts of a signal cycle during which signal indications do not change.

Interval Sequence - The order of appearance of signal indications.

Master Controller Assembly - A controller assembly for supervising a system of secondary controller assemblies.

Pedestrian Detector - A detector, usually of the push button type, capable of being operated by hand.

Phase Sections - That electrical portion or program of the controller unit with its manually variable program controls which provides control of right of way and clearance interval timing and other functions for a particular phase.

Recall Switch - A manual switch on a traffic-actuated controller unit which will place a recurring demand for service on the phase when that phase is not in its green interval.

Right of Way - The right of a vehicle or pedestrian to proceed in a lawful manner.

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Signal Face - That part of a signal head provided for controlling traffic in a single direction and consisting of one or more signal sections.

Signal Head - An assembly containing one or more signal faces.

Signal Indication - The illumination of a signal section or other device, or of a combination of sections or other devices at the same time.

Signal Section - A complete unit for providing a signal indication consisting of a housing, lens, reflector, lamp receptacle and lamp.

Split - A division of the signal cycle length allocated to each of the various phases. (Normally expressed in percent).

Traffic-Actuated Controller Assembly - A controller assembly for operating traffic signals in accordance with the varying demands of traffic as registered with the controller unit by detectors.

Traffic Phase - The right of way, change and clearance intervals assigned to a traffic movement or combination of movements.

654-2 MATERIALS

654-2.01 General

- a. All electrical equipment shall conform to the applicable standards of the National Electrical Manufacturers Association (NEMA), the Underwriters Laboratories, Inc. (UL), and the Electronics Industries Association (EIA). In addition to the requirements of the plans, these specifications and the special provisions, all materials and workmanship shall conform to the applicable requirements and standards of the P.R. Electric Power Authority (PREPA), the National Electrical Code (NEC), the American National Standards Institute (ANSI), the Institute of Electronic and Electrical Engineers (IEEE) and the ASTM.

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b. Wherever reference is made to any of the standards or codes mentioned above, the reference shall be construed to mean the standard or code that is in effect on the date the contract is advertised for bids. Differences in standards or code requirements shall be resolved by applying the more restrictive unless otherwise approved by the Engineer.

c. Where a criterion specification is designated for any material or equipment to be installed by the name or catalog number of a specific manufacturer, such designation is intended only for the purpose of establishing the style, quality, and performance characteristics, and is not intended to limit the acceptability of competitive products. Products of other manufacturers which meet the specification requirements and which are approved as equal or better will be acceptable.

654-2.02 Traffic Signals Equipment and Materials - The specific components used in the construction of new traffic signal systems shall meet the requirements of the specifications indicated below:

<u>Material</u>	<u>Specification</u>
Traffic Signal Heads.....	723-1
Optically Programmed Signal Heads.....	723-2
Pedestrian Signal Heads.....	723-3
Traffic Signal Supports.....	723-4
Inductive Loop Vehicle Detector Systems.....	723-5
Pedestrian Push Button Detector.....	723-6
Local Traffic Signal Controller Assembly.....	723-7
Traffic Signal System Master Controller Assembly.....	723-8
Rigid Plastic Conduit.....	723-9
Galvanized Steel Conduit.....	723-10
Pull Boxes and Junction Boxes.....	723-11
Electrical Conductors.....	723-12

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<u>Material</u>	<u>Specification</u>
Telecommunication Cable.....	723-13
Grounding Materials.....	714-14
Sealant for Loop Detectors.....	705-1

654-2.03 Concrete - Concrete shall conform to the requirements of Specification 601 - Structural Concrete and shall be Class A unless otherwise specified in the plans. Reinforcing steel shall conform to the requirements of Specification 602 - Reinforcing Steel.

654-2.04 Equipment Lists and Shop Drawings

a. The Contractor shall submit to the Engineer for review, within 30 days following the award of contract and before purchasing materials or equipment for this work, a list of the equipment and materials which he proposes to install. The list (five copies) shall include the name of manufacturers, size, and identifying number of each item, descriptive literature, drawings, specifications, manuals and such other data as may be required to evaluate it.

b. The Contractor shall also submit to the Engineer for review and approval, five copies of manufacturer's shop drawings, structural design computations, schematic wiring diagrams, and scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment. The drawings shall show the location of the installation and shall list all the equipment to be installed in each cabinet.

c. The submittals for the traffic signal support structures, traffic and pedestrian signal heads, loop detector units, pedestrian detectors, and the local and master traffic controller assemblies shall be accompanied by a certification from each manufacturer to the effect that the equipment meets all the requirements of the plans and specifications. In the event that any item is not exactly in accordance with the

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plans and specifications requirements, the certificate shall identify and explain each such difference.

d. All equipment operation and maintenance manuals, detailed parts lists, and diagrams required under Specification 723 shall be submitted at the time that the previously approved equipment is delivered to the project.

e. The approval of shop drawings and diagrams by the Engineer shall not relieve the Contractor of his responsibility for correcting any deficiencies due to erroneous or inconsistent dimensions, notations, omissions or other errors, or for the proper functioning of the completed installation, at his expense.

654-2.05 Warranties and Guarantees

a. All the traffic signal system equipment and devices shall be guaranteed against defective parts and workmanship under manufacturers warranties. The warranties shall be in accordance with customary trade practice but shall be for a period of not less than one year from the date of satisfactory initial start-up and placing in operation at the project site, and shall cover the full costs of materials necessary to repair or replace the defective component.

b. The Contractor shall guarantee the satisfactory installation and in-service operation of all the traffic signal system and related components for a period of six months following the acceptance of the project by the Authority. During the warranty period the Contractor shall repair or replace, at no expense to the Authority, any equipment, materials or work that does not provide satisfactory operation due to equipment, materials and/or installation deficiencies.

c. Any items repaired or replaced within the above guarantee periods shall be guaranteed for an additional period, meeting the requirements specified above, from the

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date of acceptance of the repaired or replaced item by the Authority.

d. The Contractor shall deliver to the Engineer, prior to the acceptance of the project, the manufacturers and his warranties and guarantees required above.

654-3 CONSTRUCTION REQUIREMENTS

654-3.01 General

a. The Contractor shall obtain all necessary permits and inspections required by PREPA and any other applicable laws and regulations, and shall pay all required fees as subsidiary obligation under the contract pay items.

b. Construction shall conform to the details shown on the plans; however, the location of support structures, signals, detectors, controllers, conduits and other appurtenances shown on the plans are approximate only and the exact location will be established by the Engineer in the field.

c. Upon completion of the work the Contractor shall submit "As Built" plans incorporating any changes in the original plans.

d. All systems shall be complete, fine tuned and in operating conditions at the time acceptance of the project is requested.

654-3.02 Maintenance of Existing Signal Systems

a. The Contractor shall be responsible for maintaining in effective operation any traffic signal systems existing within the project limits during the progress of the work and until such time as the new signals are in operation and removal of the existing ones is authorized by the Engineer.

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b. If during the course of construction of the new signal systems, part of the existing systems need to be relocated or modified to accommodate the new work, the Contractor shall perform such work as part of his obligations under this contract item.

c. When ordered by the Engineer, the Contractor shall remove all those portions of the existing signal systems scheduled for removal including, but not limited to, controllers, signal heads, support structures, cables, conductors and associated hardware and appurtenance. The removed equipment and materials shall be delivered to the Authority at the locations specified. Care shall be exercised in the removal and storage of existing equipment to prevent damage. The Contractor shall be responsible for the safekeeping of such equipment until delivery to the Authority.

d. For existing signal systems to be maintained in operation by the Contractor, the Authority will continue providing the following services:

1. Operating and maintaining the existing electrical facilities, signal heads and controllers except when such facilities are damaged or affected by the Contractor, who shall then be responsible for any required repairs.
2. Repairing or replacing existing facilities damaged by public traffic.
3. Providing electrical energy for the operation of the existing facilities.

e. Work under this item does not include the furnishing, installation, operation, maintenance and eventual removal of temporary traffic signals to be erected as called for in the contract documents. Such work is to be covered and paid for

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under the provisions of Specification 638 - Maintenance and Protection of Traffic.

654-3.03 Excavation and Backfilling

- a. It will be the responsibility of the Contractor to make the necessary contacts with utilities and others who have underground installations in the project area. Any damage to existing facilities caused by failure of the Contractor to notify utilities in advance of the work or other negligence by the Contractor shall be repaired by the Contractor at no expense to the Authority.
- b. The Contractor shall do all excavation, backfilling and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces and other materials necessary to complete the work in accordance with the plans and specifications.
- c. Excavation and backfilling shall conform to the applicable requirements of Specification 205 - Trench Excavation and Specification 206 - Excavation for Structures, supplemented as follows:
 1. Trenches for conduits will be excavated to the lines, grades, widths and depths shown on the plans or established by the Engineer. Unless otherwise specified, conduit trenches shall be dug to a minimum depth of 60 centimeters.
 2. In making excavations in paved surfaces, cuts shall be made with an abrasive type power saw along the neat boundaries of the area to be removed as specified in paragraph 3.04b below.
 3. All conduit trenches shall be backfilled with portland cement concrete meeting the requirements of Specification 305 - Lean Concrete Base or of Class B

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Concrete under Specification 601 to the depth shown on the plans.

4. The remainder of the trench above the concrete backfill shall be backfilled with material meeting the requirements of paragraph 205-3.07 a. of Specification 205 - Trench Excavation. However, when a selected backfill material is called for in the plans, the backfill used shall meet such requirements.

5. The soil backfill above the concrete shall be placed in 15 centimeter layers and compacted by mechanical tamping tools.

6. All excavations for pole or pedestal concrete foundations shall be made to the neat lines of the foundations and the concrete must be placed directly against the sides of the excavation except where otherwise required or authorized by the Engineer. On completion of work, the adjacent surfaces shall be restored and finished to correspond with the existing surrounding surfaces.

7. Unless otherwise authorized by the Engineer, all backfilling and the removal of surplus excavated material shall be completed within 48 hours, after the opening of the excavation. Surplus material shall be disposed of outside the right-of-way or at locations within the project approved by the Engineer. The excavation site shall be cleaned up and left in a neat condition satisfactory to the Engineer.

654-3.04 Removing and Replacing Improvements

a. Improvements such as sidewalks, curbs, gutters, P.C. concrete and asphaltic concrete pavements, underlying materials, lawn and plants, and any other improvements required to be removed by the construction of the signal system, or broken or damaged by the Contractor's operations,

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shall be replaced or reconstructed with the same kind of materials as found in the existing work or with materials of equal quality acceptable to the Engineer, and in accordance with the applicable specification.

b. The outline of all areas to be removed in pavements, sidewalks, curbs, gutters and driveways shall be cut to a minimum depth of five (5) centimeters with an abrasive type saw, prior to removing the existing material. Cuts shall be neat and true along score lines, with no shatter outside the removal area.

654-3.05 Foundations

a. Foundations for signal support structures and controller cabinets shall be of reinforced concrete conforming to the details shown on the plans.

b. The concrete foundations shall rest on solid ground. Forms, where required or authorized, shall be true to line and grade. Tops of foundations shall be finished as shown on the plans or as directed by the Engineer. Forms shall be rigid and securely braced and shall be held in place until the concrete has set up. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete has set up.

c. All exposed portions of concrete structures shall be given a Class I finish in accordance with Specification 601. Exposed corners shall be finished with a 2.5 cm. chamfer. The projection of foundations above adjacent surfaces shall be as shown on the plans or as ordered by the Engineer.

d. Where obstructions prevent the construction of planned foundations, the Contractor shall construct an effective foundation satisfactory to the Engineer or relocate the foundations to a location designated by the Engineer. Minor modification or relocation of a designed foundation will not be considered as a changed condition.

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e. Foundations for signal support structures and controller bases shall be provided with conduits for the conductor systems and for the ground connection as shown on the plans.

f. Special foundations shall conform to the applicable portions of the specifications listed herein, to the details shown on the plans and to any special requirements.

654-3.06 Fabrication and Erection of Signal Supports

a. The signal support structures shall be fabricated and installed in accordance with the details and dimensions shown on the plans, or as directed by the Engineer, including all necessary hardware and appurtenances.

b. Mast arms shall be fastened to the pole or shaft prior to erection unless otherwise approved.

c. The protective wrapping shall not be removed from any of the aluminum shafts or mast arms until authorized by the Engineer. The Contractor shall be responsible for repairing any defects or damage to the posts and arms due to rough handling during loading, shipping, unloading, storage and erection. The Contractor shall satisfactorily repair or replace, at his expense, any component so damaged prior to its acceptance.

d. Poles shall stand plumb under dead load. Before erection of the poles, the areas of concrete upon which the bases are to be set shall be dressed to provide for proper seating.

e. Mast arm signal poles shall be leveled by the use of shims or leveling nuts supplied with the pole. Before the pole is loaded it shall be raked back in excess of the calculated deflection and then plumbed after the loads are applied by adjustment of the shims or leveling nuts. When the pole is in its final position, the bottom of the signal head mounted at the

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end of the mast arm shall be 17 to 19 feet above the pavement surface unless otherwise shown on the plans.

f. After the poles are leveled the voids, if any, between the base and the foundation shall be filled with grout or silicon sealant. Each pole shall be grounded in accordance with Article 654-3.07 below.

g. The length of poles for post top mounts shall be such that the bottom of the standard traffic signal head shall be not less than 10 feet above the curb. For optically programmed signal heads, the height shall be 12 feet above the curb and for pedestrian signals it shall be 7 feet.

h. The 4 inch galvanized steel post for pedestrian push button units shall be coupled to a reducer in the concrete foundation. The reducer shall in turn be coupled to a 2-inch elbow which shall extend one inch outside the concrete base for connection to the underground PVC conduit. The steel post shall extend at least 12 inches into the concrete base and shall be of such length that its top is 4 feet above the adjacent surface. The top of the post shall be closed with a galvanized steel cap. The post shall be painted federal highway yellow in accordance with Specification 653.

i. For span wire assemblies the Contractor shall determine the length of suspension, messenger and other wires required for the span including sufficient allowance for fastenings and required sag after adjustments. All the necessary hardware for attaching the suspension and messenger wires shall be capable of developing the full strength of the corresponding wires. Unless otherwise shown on the plans, the bottom of the signal heads suspended from the span wire shall be 17 to 19 feet above the pavement surface.

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654-3.07 Grounding

- a. Grounding shall be in accordance with and the requirements of the NEC and PREPA.
- b. Grounding for all signal support structures and controller installations shall be as shown on the plans or as directed by the Engineer. The ground system shall be electrically connected to the grounding terminal on the pole or support structure, or on the controller cabinet.

654-3.08 Conduits

- a. General
 1. All conductors shall be run in conduit except overhead on span wires and in temporary installations, and where conductors are run inside poles and bracket arms.
 2. Conduits shall be of the types and sizes shown on the plans. The Contractor may, at his option and expense, use conduit of a larger size than specified provided the larger size is used for the entire length of the run from outlet to outlet. No reducer couplings shall be permitted except where specifically indicated on the plans.
 3. Conduit runs shown on the plans may be changed as to location only, with the approval of the Engineer, to avoid obstructions.
 4. All conduit bends shall be standard factory bends. Where factory conduit bends are not commercially available, or for locations requiring special bends, conduit may be bent in the shop or field provided that:

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(a) Radius of bends shall be the longest practicable but not less than six times the inside diameter of the conduit.

(b) The bends are made without any crimping, flattening or appreciably reducing the internal diameter of the conduit.

(c) No bends will be accepted for galvanized steel conduit which show any evidence of destruction of the protective coating.

5. The ends of conduits whether field or shop cut shall be made square and true so that the ends will butt or come together for the full circumference thereof. When a standard coupling cannot be used for coupling steel conduit, an approved threaded union coupling shall be used. All couplings for steel conduit shall be tightened until the end of the conduits are brought together, providing a good mechanical connection throughout the entire length of the run.

6. All steel conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends of the conduit, including conduit nipples in cabinets, shall be provided with a metallic conduit ground bushing having a smoothly rounded molded insulated insert. Grounding type bushings shall always be used for steel conduits unless otherwise specified. When an open conduit ends below ground, the Contractor shall furnish and install a non-hardening pipe compound that will prevent the entrance of moisture.

7. Underground conduit runs and conduit risers in poles shall be installed as needed even though not shown on plans.

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8. Non-metallic type conduit shall be cut with a hacksaw or other approved tool and connections shall be of the solvent weld type. The ends of these conduits shall be capped until wiring is started.

9. All spare conduits for future use shall be capped at both ends.

b. Underground Conduit

1. Conduit shall be installed as shown on the plans within the required excavation. Unless otherwise specified, the conduit trench shall be 20 centimeters wide and a minimum of 60 centimeters deep.

2. Conduit shall be seated on metal chairs or PVC spacers in the trench that will raise it 7.5 centimeters above the trench bottom with no sagging between supports.

c. Conduit in Structures

1. Conduit which is to be embedded in structural concrete shall be either rigid galvanized steel or rigid PVC unless otherwise specified. An expansion joint of an approved type shall be installed at every expansion joint in the structure that the conduit crosses.

2. For exposed installation on structures, the conduit shall be rigid galvanized steel and shall be attached with approved clamps or straps.

d. Testing

1. All conduits installed shall be tested for clear bore and correct installation by the Contractor using an appropriate snake before the installation will be

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accepted. Snaking of the conduits shall be done by the Contractor in the presence of the Engineer or his representative. Any obstructed conduit shall be cleared by the Contractor and he shall replace any defective conduit at his expense.

2. A record shall be kept as the conduits are tested and, after testing, all the empty conduits and duct openings shall be capped or plugged by the Contractor in accordance with Article 654-3.08 above.

654-3.09 Pull Boxes and Junction Boxes

a. Pull boxes and junction boxes shall be installed at the approximate locations shown on the plans but pullboxes shall be spaced at not more than 45 meters from each other. The Contractor may, at his expense, install additional junction or pull boxes to facilitate his work.

b. The tops of pull boxes and handholes installed in sidewalk or paved areas shall be flush with the surrounding grade or top of adjacent curb. Those installed in the ground shall have the tops projecting 5 cm. above the adjacent grade.

c. All conduit entrances into pull boxes and handholes shall be made watertight.

654-3.10 Electrical and Telecommunication Wiring

a. No cables shall be installed in the conduits until after the conduit system is completed, tested and accepted.

b. Cables shall be pulled through the conduits by hand using care so as not to damage them. A cable grip designed to provide a firm hold upon the exterior covering of the cable may be employed but the use of winches or other mechanical pulling equipment will not be permitted. If required, the cables shall be treated with a UL approved lubricant suitable for the type of cable being pulled.

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c. Electrical cables shall contain the required number of conductors as shown on the plans and required by the system. The substitution of several cables to attain the required number of conductors in one cable will not be permitted except for service installation cable.

d. Telecommunication cables shall be of the gauge and number of pairs called for in the plans and shall conform to the requirements of the controller manufacturer. A minimum of 4 spare pairs shall be provided.

e. Cables shall be installed to form a continuous circuit between the designated equipment terminals. All cable runs from the controller to the traffic signal heads shall be continuous without splices except for the required splice at the base of the support structure. Interconnection of signal heads with the same cable shall be in the signal head terminal block.

f. Where long runs of cable are required such as for interconnect circuits, splices may be made but shall be constructed with a standard manufactured, epoxy or approved equal, splicing kit. Splices shall be constructed only at a handhole, pull box, junction box or access opening. All splices shall be insulated to provide a watertight connection capable of satisfactory operation under continuous submersion in water.

g. The cables shall be neatly routed to their destinations in cabinets, pole bases, pull boxes, and all other terminations. Cable connections at the control cabinet shall be made at the terminal boards provided for this purpose. All stranded wires inserted under a binder screw shall be equipped with a solderless, pressure type spade connector. Only one stranded wire shall be used with each spade connector. Spade connectors shall not be used on solid non-stranded wire.

h. One meter of cable slack shall be provided at pull boxes and handholes and 0.5 meter at cabinets and foundations. Cable in pull boxes, handholes, junction boxes

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and cabinets shall be identified as to functions by the use of aluminum, brass or plastic cable markers. If a wire numbering system is used for identification, the key to the system shall be placed along with the wiring diagram in the controller cabinet.

- i. Cables coming out of mast arms or along a messenger cable and going into a signal head shall be provided with adequate drip loops.
- j. Conductors entering the controller cabinets shall be dressed neatly with tie wraps and trained along the base and back of the cabinet to the terminal board. Spare conductors shall be taped and neatly coiled in the bottom of the cabinet. Ends of spare conductors shall be taped.
- k. Conductors installed on span or messenger cables shall be tied with non-corrosive metal lashing or messenger rings, or weather resistant plastic cable bands, at intervals not greater than 30 centimeters. Taping will not be permitted.
- l. Each circuit shall be tested for continuity.

654-3.11 Signal Heads

- a. The specified standard and optically programmed traffic signal heads and pedestrian signal heads shall be installed as shown on the plans and on the signal support structures indicated.
- b. Each signal head shall be assembled with the size, type and number of faces, sections, brackets, trunions, adapters, backplate, louvers and hardware necessary to meet the configuration specified on the plans.
- c. Each signal head shall be erected so that it is plumb, correctly aligned with respect to the traffic direction served, with all fittings tight, and presenting a neat appearance.

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d. Optically programmed signal heads shall be installed, directed and veiled in accordance with the manufacturer's instructions, the plans, and the Engineer's visibility requirements.

e. Signal heads shall be bagged and maintained in bagged condition to the satisfaction of the Engineer until placed in operation. The bagging material shall be burlap or similar opaque material, and shall be adequately and neatly secured so that it is not blown away.

654-3.12 Inductive Loop Vehicle Detector Systems

a. A complete system installation shall include one (LC-1), two (LC-2) or four (LC-4) sensor wire loops embedded in precast PC concrete slabs or in slots sawed in a bridge deck or PCC pavement, the loop detector unit (4-channel type) installed in the traffic signal controller cabinet or in its own cabinet, and the conduit and lead-in wiring from nearest pull box indicated on the plans to the loop detector units.

b. Sensor loops for inductive vehicle detector systems shall be installed at the locations and in accordance with the details and dimensions shown on the plans.

c. Pull boxes, conduits and curb cuts shall be completed before beginning the wire loop installation.

d. On existing PCC pavements and bridge decks, the configuration of the loop shall be outlined at the specified locations and the loop slot cut in the pavement with a power saw to a width of 1.25 centimeters (1/2") and a depth of 5.0 centimeters (2"), or as otherwise specified in the plans.

e. For precast slab installations, a 1" diameter flexible liquid-tight metallic conduit, commercial grade, unless other type conduit is shown on the plans, shall be installed between the loop slot and the nearest pull box as shown on the plans.

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This conduit shall be placed in a 30 centimeter (12”) deep trench which shall be backfilled with PC concrete.

f. Prior to installing the wire loop, the slot shall be flushed with clean water to remove all traces of slurry and debris. The slot shall be cleaned and dried with compressed air immediately before placing the loop wire.

g. The loop wire shall be installed starting at the pull box, through the conduit, in the loop slot for the specified number of turns, and back through the conduit to the pull box. No splices outside the pull box shall be permitted in the loop circuit. The single conductor loop wire shall be spliced with an approved waterproof epoxy type splice, at the pull box, to the two-conductor cable leading to the loop detector unit.

h. The loop wire shall be depressed in the slot, using a blunt tool to avoid damaging the wire insulation, and the slot filled with the specified nylon rope and sealant.

654-3.13 Pedestrian Push Button Detector Assembly

a. The pedestrian push button detector assemblies, including the signs, shall be installed at the locations and in accordance with the details and dimensions shown on the plans. Each push button assembly shall be installed on an existing pole, a newly installed traffic signal pole or on its own post as specified on the plans.

b. The push button unit shall be installed 1.05 meters (3.5 feet) above the existing sidewalk or pedestrian grade with the sign immediately above or below it. The orientation of the push button shall be convenient to the pedestrians intending to cross the street at the marked crosswalk.

654-3.14 Traffic Signal Controllers

a. Local Traffic Signal Controllers

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1. Each traffic signal controller assembly shall be installed on a PC concrete base at the location and in accordance with the details and dimensions shown on the plans.

2. The concrete base shall be dimensioned to fit the dimensions of the controller cabinet being furnished. The base shall be provided with all the conduits required for the wiring of the signal system. It shall also be provided, except when the controller operates under a central power system, with a power meter base and circuit breaker box as shown on the plans and meeting the requirements of PREPA. Where the concrete base is located in an unpaved area, a PC concrete pad 0.60-meter wide by 0.90-meter long by 0.10-meter thick shall be constructed in front of the cabinet door.

3. The controller assembly shall include all the basic controller equipment plus all auxiliary equipment and accessories necessary to provide the sequence of operations and timing coordination shown on the plans and required by the traffic signal system being installed.

b. Master Traffic Signal Controllers

1. Independent master traffic signal control assemblies for interconnected traffic signal systems shall be installed in their own master control room which shall be constructed under the provisions of Specification 655 - Traffic Signals Master Control Room, unless otherwise provided in the contract documents.

2. Where the master control functions are performed by a local controller provided with a secondary coordination unit the latter shall be

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installed as a component part of the local controller assembly.

654-3.15 Intersection Power Centers - When a local signal controller at an intersection operates as part of an interconnected traffic signal system and receives its electrical power from a central power system, a dry type transformer housed in its own separate cabinet shall be provided and erected on the same concrete pedestal base as the intersection controller. These intersection power center transformers shall be furnished and erected as part of the central power system under Specification 656.

654-3.16 Traffic Counts, Adjustment and Fine Tuning

a. After placing the new traffic signals in operation, the Contractor shall conduct traffic counts at each signal controlled intersection to obtain the necessary data for adjusting and fine tuning the system. These traffic counts shall follow the format furnished by the Authority and shall:

1. Cover 14 hour periods from 6:00 AM to 8:00 PM on a weekday, a Saturday and a Sunday.

2. Be summarized by 15-minute periods.

b. The signal controller's programs shall be adjusted or new programs developed as needed to provide an efficient handling of all movements at the intersection. For interconnected systems, the programs shall be adapted to the traffic and progression requirements for the various time periods to cover daily and weekly variations in traffic flow.

c. For coordinated systems that are to operate in a traffic responsive mode, the number of programs to be developed shall be not less than 5 but will vary depending upon the capacity of the controller and the need of the intersections and/or system. The Contractor shall submit a listing of the programs he proposes to prepare for review by the Authority.

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654-3.17 Functional Test

- a. After all the traffic signal equipment has been installed, tested, adjusted and fine tuned, a functional test of the completed system shall be performed to demonstrate that every part of the system operates in accordance with the plans and specifications, and to the satisfaction of the Engineer.
- b. The functional test for each signal system shall consist of not less than ten days of continuous satisfactory operation. If unsatisfactory performance of any of the system components is discovered during the test period, the condition shall be corrected by the Contractor and the test repeated until ten days of continuous satisfactory operations are obtained.

654-3.18 Traffic Signals Operational Support Package -

Prior to final acceptance of the project, the Contractor shall deliver to the Authority all the items of equipment and spare parts listed in the contract documents as the traffic signals operational support package.

- a. The spare parts delivered shall be in new condition and shall be completely interchangeable with and of the same quality as the corresponding parts in the installed equipment.
- b. Equipment furnished shall be in new condition and shall meet all the applicable requirements of Specification 723 - Traffic Signal Materials. Each unit of equipment supplied shall be of the same model as, produced by the same manufacturer, and be fully interchangeable with the corresponding unit of equipment installed in the project.
- c. When traffic signal controller units are included in the package, these shall be furnished with a cabinet meeting the requirements of Specification 723 and equal in size and details to the corresponding installed cabinets.
- d. In case of a failure in the traffic signal system occurring during the adjustment, fine tuning or functional test periods, the Contractor will be allowed to borrow and use any

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spare parts or equipment units already delivered to and accepted by the Authority for the repair and correction of the failure. However, prior to final acceptance of the project, the Contractor shall deliver to the Authority the replacement for the parts and/or equipment borrowed by him.

e. The Contractor shall provide for the parts and equipment furnished in the package the same manufacturer's warranties as required for installed equipment in paragraph 654-2.05a of this specification, except that the one-year warranty period shall begin on the date the particular item delivered is accepted by the Authority.

654-3.19 Pre-Formed Inductive Loop Vehicle Detector Systems - A complete system installation shall consist of the pre-formed inductive sensor loop, the loop detector unit installed in the traffic signal controller cabinet or on its own cabinet, and the conduit and lead-in wiring from nearest pull box indicated on the plans to the loop detector units.

a. Pre-formed sensor loops for inductive vehicle detector systems shall be installed at the locations and in accordance with the details and dimensions shown on the plans and in accordance with the requirements of this specifications.

b. Install pre-formed inductive loop vehicle detectors according to the following general requirements:

1. The pre-formed loops shall be installed to a minimum depth below final grade of 5 inches on hot plant mix bituminous pavements and 3 inches minimum on Portland cement concrete pavements.

2. Secure with a knot the splice between the loop conductor and the lead-in no. 4 cable with two (2) conductors shielded, welded and covered with heat shrink tube.

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3. The Contractor shall comply with PRHTA standard installation procedures from the pavement edge to the pull box.

4. The distance from the stop line to the quadrupole pre-formed loop shall be at least 6 inches and 12 inch maximum.

c. The installation procedure for pre-formed inductive loop vehicle detectors on new Portland cement concrete pavement or new hot plant mix bituminous pavement shall be as follows:

1. Test pre-formed loop for continuity and resistance.

2. Lay out the pre-formed loop to its full size at the location and geometry as specified on plans.

3. Position bend supports on loop where corners should be formed according to details on figures 654-1 and 654-2.

4. Use loop support clamps to hold down the bend supports at the corners of the square or rectangular loop according to details on figures 654-1 and 654-2.

5. Route the feeder cable/outer tubing to the desired termination point. Loop support clamps shall be used to secure the outer tubing.

6. Only for asphalt pavements; secure the loop in position using a thin layer of asphalt.

7. Pour Portland cement concrete or hot plant mix bituminous pavement directly over the pre-formed loop.

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d. The installation procedure for pre-formed inductive loop vehicle detectors on existing Portland cement concrete pavement or new hot plant mix bituminous pavement shall be as follows:

1. Test pre-formed loop for continuity and resistance.
2. Lay out the pre-formed loop its full size at the location and geometry as specified on plans.
3. Position bend supports on loop where corners should be formed.
4. Use loop support clamps to hold down the bend supports at the corners of the square or rectangular loop.
5. Mark the loop outline on the pavement surface using either a string or aerosol spray paint.
6. Remove the pre-formed loop and proceed to saw cut the pavement with a ½ inch saw blade.
7. Drill a 1½ inch diameter hole on each corner as shown on figure 654-3.
8. Clean debris from saw slot with oil free compressed air and allow surface and slot to dry completely.
9. Confirm that the required depth has been reached.
10. Lay out the pre-formed loop over the slot.
11. Use a wood stick or roller to insure the pre-formed loop is in the bottom of the slot. **Do not use metal objects for this purpose.**

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12. Apply traffic detector loop sealant approved by the Engineer over the installed loop. The sealant shall be applied and cured according to the manufacturer's recommendations. The sealant shall be filled no more than ¼ inch of the roadway surface as shown on figure 654-3. Do not overflow the slot.

e. The installation procedure for pre-formed inductive loop vehicle detectors on new bridge decks shall be as follows:

1. Test pre-formed loop for continuity and resistance.
2. The pre-formed loop shall be tied directly to the reinforcing steel using plastic (non-metallic) ty-raps prior to pouring the Portland cement concrete for the bridge slab.

f. The installation procedure for pre-formed inductive loop vehicle detectors on existing bridge decks shall be as follows:

1. Test pre-formed loops for continuity and resistance.
2. Mark the loop outline on the pavement surface using either a string or aerosol spray paint.
3. Saw-cut pavement with a ½ inch saw blade to a 2 inch depth.
4. Clean debris from saw slot with oil free compressed air and allow surface and slot to dry completely.
5. Use a wood stick or roller to insure the pre-formed loop is in the bottom of the slot. **Do not use metal objects for this purpose.**

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654-4 METHOD OF MEASUREMENT

654-4.01 The maintenance, modification, relocation, replacement or removal and delivery to the Authority of all existing traffic signal systems and equipment within the project limits as described in Article 654-3.02 will be measured as a single lump sum item.

The components of each pre-formed inductive loop vehicle detector system will be measured as follows:

- a. Each pre-formed sensor loop installation completed and accepted of the size specified on plans will be measured as a unit. The complete pay unit includes all the loop wiring to the nearest pull box, and all the necessary excavation, backfill, conduit, concrete, reinforcing steel, nylon rope, sealant and miscellaneous items required to complete the installation as shown on plans or as ordered by the Engineer, and covered under article 654-3.18.
- b. Each loop detector unit, 4-channel type, furnished, installed and accepted will be measured as a unit. The complete unit shall include its own cabinet and concrete base, if required, and all necessary hardware and accessories.
- c. The loop detector lead-in cable will be measured as specified in Article 654-4.06.

654-4.02 The following items of materials and work will not be measured for direct payment but shall be a subsidiary obligation of the Contractor with their costs included under the various traffic signal system pay items where they occur:

- a. All excavation, bedding and backfill required for foundations, poles, controller bases, conduits, pull boxes, induction loops and cables as described under Article 654-3.03.

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- b. The removal and replacing of existing improvements required for the construction of the traffic signal system as described under Article 654-3.04.
- c. PC concrete and reinforcing steel required for foundations of poles and other signal support structures, pull boxes, conduit trench backfill, controller bases, and other traffic signal system structures.
- d. Metallic pull and junction boxes in conduit lines.

654-4.03 Traffic signal supports of each specified type furnished, installed and accepted will be measured as a unit. Each traffic signal support unit shall consist of the complete installation, including foundations, poles, bases, anchor bolts, mast arms, conduits, wiring, ground, span and messenger wires and all necessary hardware and appurtenances required to provide a complete installation except those specifically identified as separate pay items, such as signal heads and pedestrian push buttons.

654-4.04 Conduit will be measured by the linear meter of each type and size specified, installed complete according to the plans or as ordered by the Engineer and accepted. The work includes all excavation, bedding, concrete backfill, other backfill, expansion joints, clamps, fittings, hangers, and other required installation hardware. Conduits within foundations, pull boxes, concrete bases and included within signal support structures, except when used as an exposed riser, will not be measured for payment as these are subsidiary to the respective pay items.

654-4.05 Concrete pull boxes will each be measured as a unit of the type and size specified, complete, installed and accepted. Each complete unit includes the required excavation, bedding, drainage well, concrete foundation, backfill, conduit, hooks, frames, covers and all necessary miscellaneous hardware.

654-4.06 Electrical conductors, telecommunication cable and loop detector lead-in cable, will be measured by the linear meter of

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each class, size and number of conductors or pairs specified and actually installed and accepted.

a. The work includes all required connectors, approved splices, testing, cable identification markers and any necessary hardware and fittings. Measurement will be made to the bases of signal support structures and traffic controller bases. All wiring within signal support structures (including span wire system), controller cabinets and sensor loops will not be measured for payment as this wiring is a subsidiary obligation with its cost included in the respective pay unit.

b. In the event that the traffic control coordination or communication equipment proposed by the Contractor and approved by the Engineer requires a different class, size or larger quantity of cable than that called for in the contract documents, the approved substitute cables shall be installed but measurement for payment shall not exceed the amount required if the specified cable had been installed.

654-4.07 Signal heads will be measured on the basis of each unit of each type furnished, installed and accepted. Basic types include standard traffic heads, optically programmed traffic heads, lane signals and pedestrian signal heads. These are further identified by the number and sizes of faces included in each unit. The completed installation includes all the equipment and hardware necessary, mounted on its traffic signal support structure and integrated into the traffic signal system.

654-4.08 The components of each inductive loop vehicle detector system will be measured as follows:

a. Each sensor loop installation completed and accepted of the type (precast slab, or saw cut) and of the number of sensor loops (LC-1, LC-2 or LC-4) specified will be measured as a unit. The complete pay unit includes all the loop wiring to the nearest pull box. and all the necessary excavation, backfill, conduit, concrete, reinforcing steel, nylon rope, sealant and miscellaneous items required to

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complete the installation as shown on the plans and covered under Article 654-3.12.

b. Each loop detector unit, 4-channel type, furnished, installed and accepted will be measured as a unit. The complete unit shall include its own cabinet and concrete base, if required, and all necessary hardware and accessories.

c. The loop detector lead-in cable will be measured as specified in Article 654-4.06 above.

654-4.09 Each pedestrian push button detector installed and accepted will be measured as a unit. The complete unit includes the push button, the sign and all necessary mounting hardware and fittings.

654-4.10 Each local traffic signal controller assembly of the type specified furnished, installed and accepted will be measured as a unit. The complete unit shall include the concrete base, the cabinet, and all the basic and auxiliary electrical and electronic equipment and accessories required to provide the traffic control operations specified in the contract documents. Any required secondary coordination units, either self-contained modules installed in the controller cabinet or provided as a built-in feature of the controller, shall be considered as part of the local controller assembly and will not be measured separately.

654-4.11 Each independent master traffic controller assembly furnished, installed and accepted will be measured as a unit.

a. The complete unit shall include all the electrical and electronic equipment and accessories required to provide the supervision scheme to the system of local traffic controllers in a traffic responsible manner as specified in the contract document. The assembly also includes the weekly program unit time switch and all telemetry equipment installed in the master and in the local controllers to provide for communication within the system.

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- b. The master control room to house the unit will be measured and paid for separately under Specification 655 - Traffic Signals Master Control Room.

654-4.12 The traffic counts and the adjustment and fine tuning of the traffic signal system required under Article 654-3.16 will be measured as a lump sum item.

654-4.13 The functional test required under Article 654-3.17 will not be measured for direct payment but shall be a subsidiary obligation of the Contractor under the various traffic signal system pay items.

654-4.14 The traffic signals operational support package will be measured as a lump sum item including all the required spare parts and equipment furnished and accepted.

654-4.15 Traffic signal self support concrete poles for span wire installed and accepted will be measured as a single unit. Foundations, wiring, grounding, span wires, messenger wires and all necessary hardware and appurtenances required to provide a complete installation as required by standard specifications, standard drawings and details shown on plans shall be considered as a subsidiary obligation under the traffic signal self support concrete pole pay item.

654-4.16 Traffic signal self support concrete poles for span wire installed and accepted will be measured as a single unit. Foundations, wiring, grounding, span wires, messenger wires and all necessary hardware and appurtenances required to provide a complete installation as required by standard specifications, standard drawings and details shown on plans shall be considered as a subsidiary obligation under the traffic signal self support concrete pole pay item.

- a. Each pre-formed sensor loop installation completed and accepted of the size specified on plans will be measured as a unit. The complete pay unit includes all the loop wiring to the nearest pull box, and all the necessary excavation,

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backfill, conduit, concrete, reinforcing steel, nylon rope, sealant and miscellaneous items required to complete the installation as shown on plans or as ordered by the Engineer, and covered under article 654-3.19.

b. Each loop detector unit, 4-channel type, furnished, installed and accepted will be measured as a unit. The complete unit shall include its own cabinet and concrete base, if required, and all necessary hardware and accessories.

c. The loop detector lead-in cable will be measured as specified in Article 654-4.06.

654-4.17 Traffic signal self support concrete poles for span wire installed and accepted will be measured as a single unit. Foundations, wiring, grounding, span wires, messenger wires and all necessary hardware and appurtenances required to provide a complete installation as required by standard specifications, standard drawings and details shown on plans shall be considered as a subsidiary obligation under the traffic signal self support concrete pole pay item.

654-5 BASIS OF PAYMENT

654-5.01 Although the various components of the traffic signal system for a project are measured and paid for as separate pay units, it shall be understood that the combination of all component pay units shall provide for a complete traffic signal system ready for operation and that any miscellaneous fees, work, equipment, hardware, software and materials necessary to complete the system, whether or not they are specifically mentioned in the contract documents, shall be furnished and installed by the Contractor at no extra cost to the Authority. The cost of all such miscellaneous items shall be considered as a subsidiary obligation of the Contractor under the various contract pay items.

654-5.02 The accepted quantities, determined as provided in Section 654-4 above for the pay items listed below which are included in the contract, will be paid for at the contract unit price per

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unit of measurement. Such price and payment shall constitute full compensation for furnishing, installing, adjusting and testing all required equipment and materials, and for all labor, equipment, tools, materials and incidentals necessary to complete each item and to provide a complete traffic signal system as required by the plans and specifications.

654-5.03 Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
Maintenance and Removal of Existing	
Traffic Signal System.....	Lump Sum
Traffic Signal Support – Post Top Mount Type..	Each
Traffic Signal Support – Single Mast Arm	
Type (<u>Length</u>).....	Each
Traffic Signal Support – Double Mast Arm	
Type (<u>Lengths</u>).....	Each
Traffic Signal Support – Overhead Bridge	Each
Type.....	
Pedestrian Push Button Post.....	Each
PVC Conduit – (<u>Diameter</u>).....	Linear Meter
Galvanized Steel Conduit – (<u>Diameter</u>).....	Linear Meter
Concrete Pull Box – (<u>Size</u>).....	Each
Electrical Conductor (<u>Class, Size, No.</u>	Linear Meter
<u>Conductors</u>).....	
Standard Traffic Signal Head – (<u>Type</u>).....	Each
Optically Programmed Signal Head – (<u>Type</u>)....	Each
Lane Control Signal Face – (<u>Type</u>).....	Each
Pedestrian Signal Head – (<u>Size</u>).....	Each
Inductive Sensor Loop.(Type)*.....	Each
Inductive Loop Detector Unit.....	Each
Inductive Sensor Loop Pre-formed _____	Each
(Size).....	
Loop Detector Lead-In Cable.....	Linear Meter
Pedestrian Push Button Detector.....	Each
Local Traffic Signal Controller Assembly.....	Each
Master Traffic Controller Assembly.....	Lump Sum
Telecommunication Cable (Type, No. Pairs).....	Linear Meter

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<u>Pay Item</u>	<u>Pay Unit</u>
Traffic Counts, Adjustment and Fine Tuning....	Lump Sum
Traffic Signal Operational Support Package.....	Lump Sum
Traffic Signal Self Support Concrete Pole for Span Wire.....	Each